TECHNICAL MANUAL

DISTELL FISH FATMETER

Model FFM-992 (small sensor)

Model FFM-692 (large sensor)

CE

© DISTELL.Com, December 2010 (Version 2.7) – for use with v2 firmware

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Introduction

This Technical Manual is intended to accompany the User Manual that is included with the Distell Fatmeter. It has been written to cover some of the more advanced ways in which the Fatmeter can be used, as well as to provide some information in the comparison between the Fatmeter and other laboratory methods.

The information here is not expected to be of particular interest to most Fatmeter users, and is aimed at researchers and other technical users.

There is, in addition, a large amount of information on the Distell website at http://www.distell.com. The website includes a 'Frequently Asked Questions' section, where we address many of the queries that have been raised in connection with the Fatmeter.

If, after reading this document and the information on the website, you have questions about or problems with the Fatmeter then please get in touch with us. Our contact details are at the end of this manual.

Creating Custom Calibrations

Note: a comprehensive guide on creating custom calibrations is available on our website at http://www.distell.com/downloads/CustomCalibrations.pdf.

Measurement methodology

Clearly define your measurement protocols

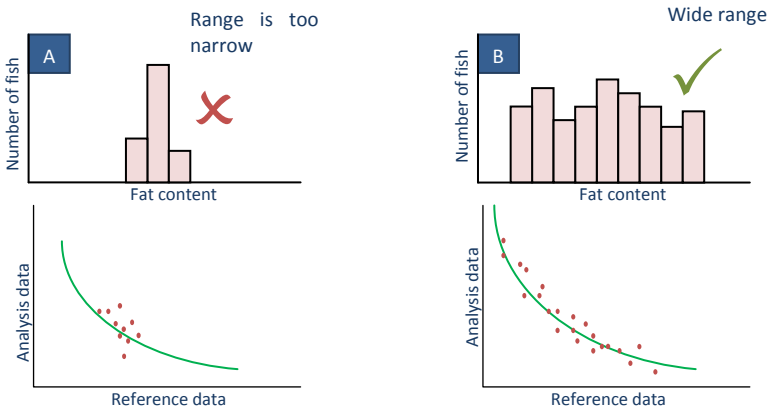
It is important to clearly define your measurement methodology for the product well in advance of the actual measurements. To help you decide on the measurement method, you will find on the CD-ROM supplied by Distell, a large number of calibration charts that outline different measurement protocols for different products. Your choice of measurement method will be determined by the weight, shape, and known characteristics of the Product and by the measurement objective.

Having considered exactly what representative measurement you wish to achieve, print out your measurement protocol in detail, and follow the method in a consistent and rigorous manner.

Selecting your product samples

To create a calibration from scratch you will need a minimum of 20 – 25 samples of product for the measurements. These samples should be evenly spaced across the range of fat content that is expected for the product from very low fat content to very high fat content. This will ensure an accurate calibration.

These graphs show two different situations. Graph 'A' shows a sample where all the fish have a similar fat content. Graph 'B' shows a sample where the fish cover a wide range of fat content from low to high.



In graph 'A', where the samples all have similar fat content, then the custom calibration will only be able to give accurate readings when used on product in the middle range of fat content. When it is used on product with high or low fat contents, i.e. outside the range represented by the samples used to create the calibration, it will not be able to give accurate data because there are no source data points in those areas.

Measurement of samples using the meter

Overview

For a given item of produce, whether meat or fish, a number of samples should be prepared. Ideally these will come from multiple sources - it is best to cover as wide a range of fat content as possible. Each of these samples will be given a unique ID then measured with the Fat Meter on (normally) the Research-1 setting. This measurement forms part of the reference data set.

Each sample is then analysed to find the exact fat content. The fat content is part of the analysis data set. The analysed fat content is paired with the Research-1 measurement. Once all the reference - analysis pairs have been obtained the custom calibration can be created.

Procedure

Having chosen your samples, and prepared your measurement protocol, you can proceed to take measurements for each sample using the Meter in the normal manner:

- Switch the meter on and allow 5 minutes for the sensor to stabilise
- Check the meter values are in agreement with the meter's check pad
- Choose the RESEARCH-1 calibration setting, known as the 'Reference Calibration'
- Set the number of readings to be averaged between 1 and 8
- Note carefully each set of readings taken on each sample, especially the average value. The readings will also be stored in meter's memory, and you can download the data at any time to the DMS. These readings are known as the 'Reference Dataset'
- After each set of readings identify each sample with a unique reference and place it in a sealed bag to retain the sample in its original condition

Once you have measured all of the samples

- Check the number of samples
- Check all the samples have been clearly marked with a unique reference
- Download your sample data from the meter and obtain a printout for reference as well as saving the data on the computer
- If the laboratory analysis is not being carried out immediately store all the samples carefully to preserve their original condition

The samples are now ready to send to laboratory for analysis by the method of your choice. The laboratory results are referred to as the 'Analysis Dataset'.

Laboratory analysis of samples

It is important that the laboratory personnel are fully informed of your sample requirements. Questions to consider are:

- What portion of the sample do you wish to analyse?
- What do you wish the analysis to represent?

In the case of a fish product

- Is it the whole fish carcass?
- Is it the trimmed fillets of the fish?
- Is it a defined section of the fish?

In the case of a meat product

- Is it a standard 300 gm sample of minced product (3 – 8mm grind)?
- Is it a whole piece of meat?

Information required from the laboratory analysis

- Fat content
- Water content
- Total solids
- Calorific / bio-energetic values

Once you have received the data from the laboratory, match each laboratory sample value (the Analysis Dataset) with the corresponding Fatmeter sample value (the Reference Dataset). This will give you a list of paired results. One way to retain this data is to create an extra column in the DMS Grid table and record the laboratory value alongside the Fatmeter sample data.

Once completed you are ready to create custom calibration using the DMS.

The calibration data file

At this point it is a good idea to locate the calibration data file supplied by Distell on your Information CD, and copy to your computer.

Copying the calibration file from CD

- Find the CD that was supplied with the meter and put it in the computer. Note that you have to use the specific CD for the meter, since the data on the CD is unique to the meter.
- Open the CD contents, typically via 'My Computer' from your desktop or the Start menu
- Browse the files until you find the 'Installation Files' folder, then highlight the 'ReferenceCalibration_xxxxx.DCF' file. Right click on the file, and choose 'Copy' from the menu
- Open your 'My Documents' Folder. If you wish to place the calibration file in a sub-folder then open that sub-folder.
- Right click on an empty space in the folder then click 'Paste' from the menu.
- Also, it is a good idea to use this folder to save your own custom calibrations, so that they are available for creating future work.

Note: Remember that the calibration file on the CD is unique to the meter with the serial number shown on the CD.

The custom calibration that is produced from this process is partially derived from the reference calibration, and so the custom calibration is also unique to the meter whose reference calibration was used.

To create a custom calibration for more than one meter, use each meter's individual reference calibration along with the same reference and analysis datasets.

Components required for a custom calibration

A Custom Calibration for your Fatmeter is produced from combining the following datasets:

- The **Reference Calibration** for your Meter (RESEARCH-1)
- The **Reference Dataset** (Fatmeter values of sample product, produced using the reference calibration)
- The **Analysis Dataset** (Laboratory values of sample product)

Creating a custom calibration

Each meter is shipped with the following calibration settings:

Product settings

- A minimum of four standard product calibrations

Research settings

- One research calibration, known as RESEARCH-1, and which is used for reference when creating your own custom calibrations
- Five vacant slots for installing custom calibrations. These slots are pre-programmed with Fish-1 to Fish-5, but these calibrations do not contain valid data.

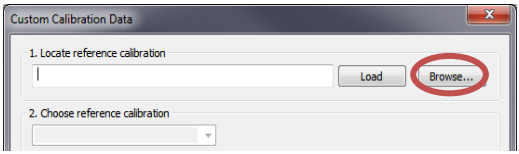
The data that makes up these product datasets is called a calibration. The DMS provides the capability to create a new calibration, and upload the calibration into one of the five vacant slots in the research group.

The process of creating a custom calibration in the DMS follows. To begin, select 'Create Custom Calibration' from the File menu in the DMS. This will open the 'Custom Calibration Data' window.

The following steps should be followed:

1. The first stage is to locate the .DCF file containing the **Reference Calibration**. (For RESEARCH-1 this file should be on the CD you received with your meter, under the file reference Calibration Module. For some older units, however, this file was not available so please get in touch with Distell to obtain it.)

   Click on the 'Browse...' button to navigate to the file then click 'Load' to load the reference calibration data from the file. Alternatively you can drag the file from the Windows desktop or a file explorer window and drop it on the Create Custom Calibration window.

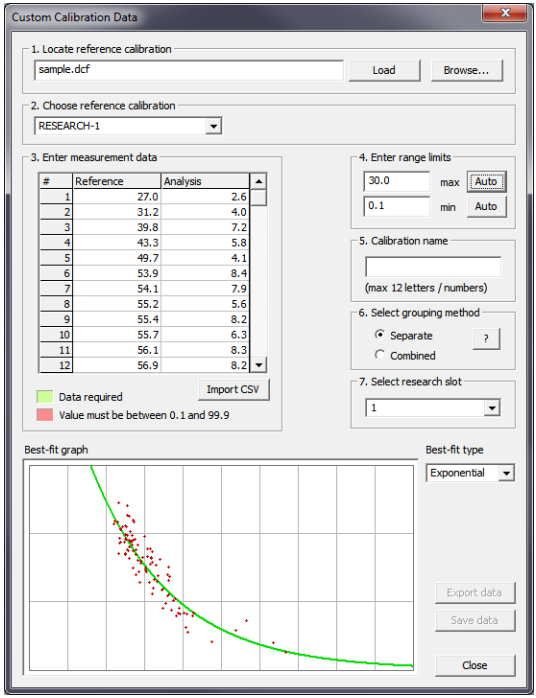


2. The second stage is to select the reference calibration you wish to use. The .DCF file in stage 1 may contain multiple calibrations, though only those used in the Fatmeter's Research menu are able to be used for this. Select the appropriate calibration from the drop-down list and the DMS will use this file as your **Reference Calibration** for calculating new custom calibration. You must choose the calibration setting that was used to take the measurements; typically this will be RESEARCH-1.

3. Using the table, enter the values for **Reference Dataset** in left hand column and **Analysis Dataset** in right hand column, for each pair of samples. The data is checked after each entry and any errors in the data will be highlighted in different colours; the key to the colours is shown below the data table. If the data shows no errors then the DMS will now create a calibration curve based upon data values entered, and the new custom calibration will be displayed in the form of a graph.

   There is an option to import this data from a CSV file, which may be more convenient for large datasets. The CSV file should be formatted as two columns with no header, the first column being the Reference value and the second column being the Analysis value.

4. The fourth stage, once the data has been entered, is to choose maximum and minimum threshold values. This allows you to limit the range of values in the calibration. Anything outside of your chosen range will appear as 'out of range' on the meter itself. The DMS will attempt to choose sensible values for these, but you can override them with your own choice if you wish.



5. The fifth stage is to enter the name of the new calibration. This is limited to 12 letters, symbols or numbers, due to the size of the display on the meters. The meter will show the calibration name given here on the display.

   Note: When measurements using this new custom calibration are downloaded to the DMS, the calibration name may show as Custom-1, Custom-2, etc. according to the slot number (see the next stage). This only happens with older meter software. With latest meter software the DMS will show the name you have selected for the custom calibration.

6. Select the grouping method according to instructions available in the Help Section of the DMS. Normally you will choose 'Separate'. If your meter is an older version, then choose 'Combined'. This choice governs which calibration slots are available in the next stage.

7. The seventh stage is to select the research setting, or slot, that the new calibration should use. In other words, which of Fish-1 to Fish-5 will be replaced by your new calibration. The documentation that you received with the meter will show you what calibrations are in which slot. Where calibrations are combined into a single list you can choose slots 5 to 9. Alternatively, where there are separate Product and Research menus available in your meter then you can choose slots 1 to 5 of the Research settings. Not all meters have all of these slots available, check the configuration of your meter to be certain. Your choice should be influenced by whether or not you have already added a custom calibration to the meter - if slot 1 is in use, for example, then you should choose slot 2 or 3 unless you'd rather overwrite the calibration in slot 1.

8. You can now save the Data in two formats:

   - For uploading your custom calibration to the meter using the DMS, save as a Distell Calibration File (.DCF). The uploading process is discussed in the next section.
   - For exporting to a spreadsheet or database save as a Comma Separated Value file (.CSV). In this form, the data is presented as a series of 1000 discrete data points that reflects the measurement range of the meter.

Note that the best-fit type is best left at Exponential for a natural calibration.

Uploading Calibrations to the Meter

Programming a meter with a new calibration setting

Note: a more comprehensive guide on uploading calibrations is available on our website at http://www.distell.com/downloads/UploadingCalibrations.pdf.

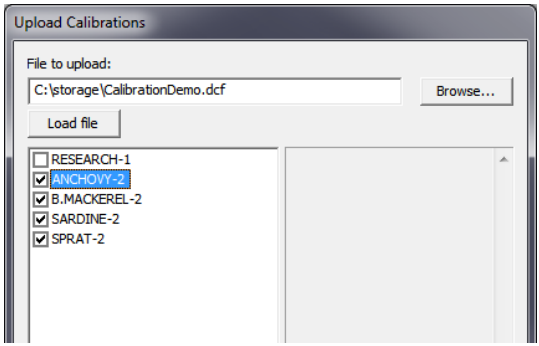
Your meter is shipped with several calibrations pre-installed, but if you have purchased an additional calibration, or you have created a custom calibration, then this option allows you to upload it to your meter.

Note: each calibration is unique to a specific meter because it has been tuned to the exact electronic profile of the sensor in the meter. You *can* upload a calibration to a different meter, but it will not give accurate results.

To upload a calibration to your meter, proceed as follows:

In the DMS

- Open the DMS, select the **File** menu, then **Upload Calibrations**.
- Locate the **Custom Calibration** file that you wish to upload. This should have a .DCF file extension. You can use the Browse... button to help you find the file. Once you have the filename, click **Load** to open the calibration file.
- The third step is to choose which individual calibrations from the file that you wish to upload to the meter. The file may contain more than one calibration, so only tick the calibrations that you wish uploaded at this time.



Important note: You should check the version of the firmware that is on your meter (this is shown when the meter is switched on).

Fatmeters with version 2.6 firmware (or higher) and Freshness meters with version 1.08 firmware (or higher) can upload multiple calibrations at once, but meters with older firmware can only upload one calibration at a time. For these older meters only the first ticked calibration will be uploaded, even though the DMS will look like it is uploading all of the ticked calibrations. To upload multiple calibrations to the older meters, you will need to go through this process once for each calibration. It is best to tick only one calibration each time.

The newer firmware will upload multiple calibrations in one operation.

In the meter

Once you have selected the calibration to upload, switch meter ON, and go to the **'Add Product'** option of the **Choices Menu** on the meter, and press the **Y (Read / Yes)** button.

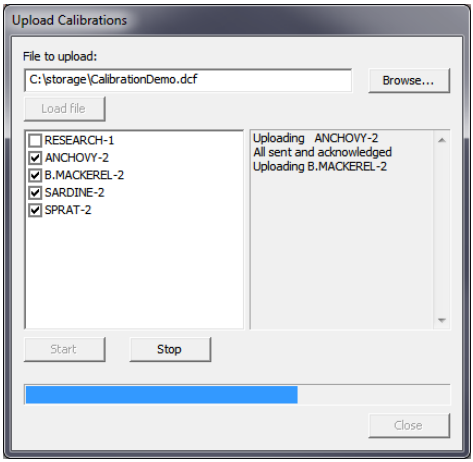
When you are ready to perform the upload, press the **Y (Read / Yes)** button at the **'Data Ready?'** prompt.

When the meter shows **'Waiting data'** you can click the Start button in the DMS to begin the upload.

You can monitor the upload progress on the meter display, and also on the computer.

Note: If you cancel the upload before it is complete you will have an incomplete calibration in the meter and measurement results will be unpredictable and inaccurate.

You should always allow the upload process to finish.



Comparison with Laboratory Methods

Fatmeter measurements vs. Foss-let method

Introduction

If you wish to test the accuracy of the Fatmeter measurements, and compare the results with the Foss-Let laboratory analysis method for an accurate appraisal of its performance, it is essential that the techniques employed are the same as those from which the original calibration data were derived.

When checking the calibration of the Fatmeter against the Foss-Let method a key element in the process is the preparation of fish samples for these determinations. The purpose of this note is to describe the procedures to be used in the preparation of these samples. For detailed instructions please refer to the User Manual and the calibration charts supplied with the meter.

Background

In attempting a calibration check of the Fatmeter, there are three points that must be understood. These are:

- The Fatmeter is primarily intended as a tool for the processor, fish farmer, or researcher. It provides a non-destructive estimate of the fat content of the fish, or fish section. Please refer to the calibration chart for the product being analysed.
- The Fatmeter is an averaging instrument and, except in clearly defined circumstances, will not make accurate measurements of the fat content of smaller, single fish e.g. herring and mackerel. Small fish require readings to be averaged from each of eight fish randomly selected from a batch, before the specified accuracy of the instrument can be achieved. On the other hand, the fat content of a single large fish such as salmon can be assessed accurately if four readings are taken from each side of the fish. These are then averaged by the instrument to provide an estimate of the fat content representing the trimmed fillets of the fish.
- All fat content measurements used in the preparation of the calibration data for the Fatmeter were obtained using a Foss-Let oil meter. This requires a 22g sample of fish flesh to be used. To allow for losses in mincing, sample of fish muscle with a minimum weight of 60g are required. It is advisable to prepare enough minced material in case a duplicate Foss-Let measurement is required, so that a sample of at least a 100g in weight is desirable. It is also good practice to carry out triplicate Foss-Let measurements on each filtrate. Any contamination of the filtrate or of the Foss-Let itself will then be immediately apparent.

Preparation & measurement of fish samples

Sprat, Sardines, Pilchards & Anchovy

Because of the small size of sprats, the sampling procedure is different to that of other fish, such as herring or mackerel. It is necessary to calibrate using larger numbers of fish, and interpret the results as a batch average (batch mean).

Before taking Fatmeter readings, the fish should first be lightly cleaned of any slime or excess water. We recommend that Fatmeter readings are taken utilising a single reading on each of a large number of fish. The Fatmeter measuring head is then applied to the skin of the intact fish at the recommended position as indicated in the calibration chart for the fish being measured. Groups of fish are selected using the Fatmeter, to lie within the following indicated range of fat/oil content:

13.7 to 15.1%	15.2 to 16.8%	16.9 to 18.7%
18.8 to 20.9%	21.0 to 23.3%	23.4% and over

The increasing size of these ranges is due to the logarithmic nature of the instrument's response. Sufficient numbers of fish are taken, in each range, to fill a 600ml beaker. This is normally between 20 and 30 fish, depending on size. The mean Fatmeter reading is then taken for each batch.

The fish then have head and tail removed, are split and gutted, and the 'butterfly' fillets so formed in each batch, are minced together in a blender. Thorough mixing is mandatory if a truly homogeneous sample is to be presented to the Foss-Let. This is especially true if the samples are to be stored, since, in high oil content fish, some separation of oil will occur.

After completion of Foss-Let analysis, the average of the results should be directly comparable with the average of the results achieved using the Fatmeter.

Small eels

For large eel samples you should refer to the calibration charts for EEL-1 and EEL-2.

Select four small eels of similar size and weight at random from a batch. Wipe off any excess slime or water from the skin then take one reading on each side of the fish. The instrument sensor head is placed on the skin of the intact fish just behind the vent (anal outlet) along the middle line. Please ensure that the sensor head is in good contact with the body of the fish (not easy with small eels).

Take the eight readings with the Fatmeter. The resulting average should accurately reflect the overall fat/oil content of the four small eels used for the test.

To accurately compare the Fatmeter results to Fosslet laboratory analysis requires that you carefully follow our procedures in the preparation of the fish samples.

Firstly, cut off the head, and remove the gut. Then remove the skin. ALL of the remainder of the fish, including bones, fins, flesh, etc. are utilised for the chemical analysis. All four prepared carcasses are minced in the blender for approximately two minutes. This procedure normally produces more mince than is required for the Foss-Let determination.

If the mince has been stored for any length of time, it should be thoroughly mixed before extracting the sample for the Foss-Let. This is particularly important with fish of known high fat/oil content, since the oil will tend to separate from the solid material of the mince.

The mean value of the fat content of the mince of the four fish is then compared to the mean value of the fat content derived from the Fatmeter readings.

Salmon & Trout

Adult salmon and trout are relatively large fish. Before taking Fatmeter readings, the fish should first be wiped to remove any slime or excess water. The Fatmeter sensor head is then applied to the skin of the intact fish on each side, just above, and parallel to the lateral line, at the positions indicated in your calibration chart.

Where the fish is between 100-500g four fish should be chosen at random from a batch. Fatmeter readings are then taken from both sides of each of the four fish. The Fatmeter will then display the average fat content of the fish tested.

Where the fish size is in excess of 500g each fish should be measured individually, with eight readings taken (four on each side of the fish). The measurement sites should be carefully selected as per instructions in this manual.

The fish are then filleted, the belly walls removed and the excess dorsal fat deposit also removed. The skin is peeled off, care being taken that no flesh is removed with the skin. The remaining fillets of the fish are then minced together in a blender for approximately two minutes. If the mince has been stored for any length of time, it should be thoroughly mixed before extracting the sample for the Foss-Let. This

is particularly important with fish of known high fat/oil content, since the oil will tend to separate from the solid material of the mince.

The mean value of the fat content of the mince of the fish is then compared to the mean value of the fat content derived from the Fatmeter readings.

Herring

When measuring small fish, e.g. below 500g, eight fish are selected at random from a batch. Remove excess water from the skin of the fish and Fatmeter readings obtained from one side of each fish. The instrument sensor head is placed on the skin of the intact fish just under the dorsal fin and above the lateral line, parallel to the backbone on the thickest part of the fish, as per calibration chart for HERRING-1.

Please take care to keep the central conductor of the sensor head away from the belly cavity and above the strip of brown flesh which runs from head to tail just under the skin in the middle of the fish.

Where larger herring need to be measured, e.g. above 500g, then use only four similar sized fish for the test. A measurement should be taken from both sides of these larger herring samples. After taking the eight readings with the Fatmeter, the resultant average should accurately reflect the overall fat/oil content of the four herring used for the test.

The fish are then filleted and the belly walls and fins removed. The skin should be lightly cut into approximately 10 mm squares to allow proper mixing in the Blender. (It is difficult to strip the skin from a herring without removing at least some of the underlying flesh). All the fillets, eight or sixteen, are minced in the blender for approximately two minutes. This procedure normally produces more mince than is required for the Fosslet determination. If the mince is to be stored, it should be thoroughly mixed before extracting the sample for the Foss-Let. This is particularly important with fish of known high fat content, since the oil will tend to separate from the solid material of the mince.

The mean value of the fat content of the eight/four fish is then compared to the mean value of the fat content derived from the Fatmeter readings.

Mackerel

The recommended sampling procedure is similar to that for herring, with the sensor head being placed approximately in the positions shown in calibration charts provided, i.e. directly under the dorsal fin.

However, where larger mackerel, e.g. above 500g, are being measured and assessed with the Fatmeter then four fish of equal size should be used. A measurement should be taken from both sides of these larger mackerel samples. We have found that there can be up to 8% difference from one side to the other of a large mackerel. Having taken the eight readings with the Fatmeter, the resultant average should accurately reflect the overall fat/oil content of the four mackerel used for the test.

With mackerel, it has been found necessary to remove the skin prior to blending. This can be done more easily than with herring, although care is still required to make certain that all the flesh is retained on the fillet. The problem of oil separating from the mince is more acute than is the case with herring because of the higher values of oil content commonly encountered.

Thorough mixing is mandatory if a truly homogeneous Foss-Let sample is to be presented. As with herring, the mean value of fat content obtained from the eight fish using the Foss-Let is compared to the mean value of fat content derived from the Fatmeter readings taken on the same eight fish.

Factors affecting results

The results obtained with the Fish Fatmeter can be affected by various factors:

Operator

The operator of the equipment must use the instrument in a consistent manner and follow the guidelines set out in this User Manual and calibration charts. Take care that:

- The sensor head is fully in contact with the sample or specimen prior to taking a reading and not at an angle to the surface. If the sensor head is not fully in contact with the fish then the Fatmeter may display an erroneous high reading.
- The sensor head is clean and no excess oil or water is present.
- The sensor head is not removed from the fish before releasing the **Read/Yes** button.

Samples / specimens

Where possible, follow diligently the guidelines within the User Manual. It is possible to use the Fatmeter on fish species other than those for which the instrument is calibrated, and in different ways, however, the results obtained will not necessarily be accurate. They should allow, however, reproducible results that may be used as a basis for calibration or measurement.

Where wholly consistent results are required, then the procedures as laid down in the calibration charts supplied must be adhered to, or, in the case of a different fish species, a specific calibration obtained from Distell. Please ensure that:

- The specimen/sample has been prepared as per guidelines.
- Any excess surface slime, water or oil on the skin of the fish should be lightly removed by wiping off the excess by hand. There is no need to completely dry the specimen/sample.
- The specimen / sample is not dehydrated. As the Fatmeter is actually measuring the water content as part of the measurement of oil content, it is important that the specimen has not been allowed to dry out.
- Where product has been frozen, it must be allowed to thaw / defrost completely before taking measurements.

Measurement recommendations

Each calibration that is available for the meter has several points that you should be aware of:

1. The species of fish that the calibration should be used with;
2. The measurement method that should be followed when using the calibration;
3. The representation of the calibration, i.e. when the Fatmeter shows a fat measurement, what does that measurement actually represent?
4. The preparation and processing involved if the fish sample was to be measured by laboratory process, in order that a like-for-like comparison can be made between the laboratory results and the calibration data.

The following pages show two sample calibration charts:

- SALMON-1 is for Atlantic Salmon. The calibration represents the fat content of two trimmed fillets with skin removed.
- HERRING-2 is for Atlantic / North Sea Herring. The calibration represents the fat content of the whole fish including skin, belly fat, fins, etc.

There are very many calibrations and associated charts available for Distell Fatmeters. The full range of calibration charts can be seen on the CD-ROM and calibration information can be found on our website at http://www.distell.com/information/calibrations/fish-calibrations.

Calibration: **SALMON-1**
Represents: Fat content of 2 x Trimmed Fillets, without skin
Species: Atlantic Salmon (*Salmo salar*)
Sample: Whole fish, skin on.

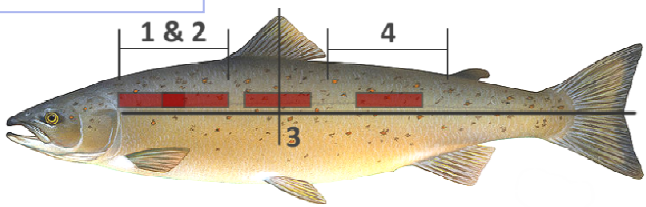
1. Selection & Preparation

Select one fish. Wipe excess water from the surface of the fish but do not dry.

2. Take readings

Place the instrument head firmly on the fish at the positions shown below and take four readings:

1 & 2: Cover the area from the head to the dorsal fin, overlap if necessary.	3. Directly below the dorsal fin.	4. Midway between the dorsal and adipose fins.



- To ensure accurate measurements keep the 'read' button pressed until the reading is stable. Once the reading is stable, release the 'read' button. It is important that you release the 'read' button *before* removing the sensor from the fish.
- When four readings have been taken, turn the fish over and repeat on the other side.

3. What do these results represent?

After eight readings the readout shows the average fat content of the trimmed fillets of this fish, subject to standard trimming techniques, *excluding* head, tail, fins, skin, belly cavity, and fat deposits at dorsal and anal fins.

Calibration: **SALMON-1**
Represents: Fat content of 2 x Trimmed Fillets, without skin
Species: Atlantic Salmon (*Salmo salar*)

Preparation of samples

It is very important that the laboratory analysis is done correctly, and truly represents ALL of the trimmed fillets, as represented by the Fatmeter measurements.

Please prepare the samples for analysis, as follows:

- Fillet the fish, taking care to retain all flesh as part of the sample.
- Remove excess fat from belly walls and the excess fat at the top of the dorsal region, and in the belly region.
- Remove any fins and skin, taking care that no flesh is removed with the skin.
- Mince both fillets in a blender for 2 minutes.
- Always ensure that the mince is thoroughly mixed. This is especially important if the mince has been allowed to stand for some time.
- Analyse with the method of your choice. Please note the Fatmeter has been calibrated against Fosslet Chemical Analysis, an AOAC recognised method, and will give the best correlation with the Fatmeter results.

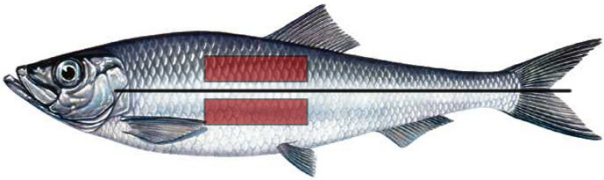
Calibration: **HERRING-2**
Represents: Fat content of whole carcass inc. belly cavity and fish roe
Species: Atlantic / North Sea Herring (*Clupea harengus*)
Sample: Whole fish, skin on.

1. Selection & Preparation

Select four small fish, or two large fish, of similar size and weight. Wipe excess water from the surface of the fish but do not dry.

2. Take readings

Place the instrument head firmly on the fish at the positions shown below and take two readings:



Take one reading above the axis line and one below.

- To ensure accurate measurements keep the 'read' button pressed until the reading is stable. Once the reading is stable, release the 'read' button. It is important that you release the 'read' button *before* removing the sensor from the fish.
- On large fish: take four readings per fish, two from each side.
- On small fish: take two readings per fish.

Repeat for the remaining fish.

3. What do these results represent?

After eight readings the readout shows the average fat content of the whole fish carcass of all fish sampled, *including* head, tail, fins, skin and belly cavity.

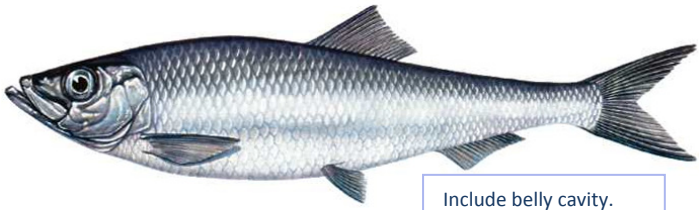
Calibration: **HERRING-2**
Represents: Fat content of whole carcass inc. belly cavity and fish roe
Species: Atlantic / North Sea Herring (*Clupea harengus*)

Preparation of samples

It is very important that the laboratory analysis is done correctly, and truly represents ALL of the fish, as represented by the Fatmeter measurements.

Please prepare the samples for analysis, as follows:

- Retain all parts of the fish carcass including head, tail, flesh, fins, bones, skin, belly cavity and fish roe.
- Cut the sample into small sections to allow the blender to mix well.
- Mince the sample in a blender for 2 minutes.
- Always ensure that the mince is thoroughly mixed. This is especially important if the mince has been allowed to stand for some time.
- Analyse with the method of your choice. Please note the Fatmeter has been calibrated against Fosslet Chemical Analysis, an AOAC recognised method, and will give the best correlation with the Fatmeter results.



Include belly cavity.

Fish Fat Analysis Standards

The Mowi Section – Atlantic Salmon

The Mowi Cut is accepted as a standard by a large section of the Salmon Processing Industry in Norway, UK and throughout Europe. It was first introduced by A. S. MOWI A/s, based in Bergen, Norway.

A section is taken at the middle of the salmon, below the dorsal fin. Please refer to illustration below.

The fillet for analysis is taken from an area 5cm either side of the lateral line. The skin is removed, ensuring that all of the brown meat/flesh is retained in the sample.

The Norwegian Quality Cut – Atlantic Salmon

This standard was drawn up by a committee appointed in the initiative of Norwegian Fish exporters and in collaboration with the Norwegian Standardisation Authorities. The Committee consisted of representatives of the export industry, feed manufacturers and the research community. This standard specifies the procedure for taking samples for measurement of characteristics affecting the quality of Atlantic Salmon (*salmo salar*).

Various fish quality measurement values, such as colour and fat in salmon, vary according to where on the fish the measurements are made. This standard will ensure that sampling is carried out in an unambiguous and well defined manner. This type of sampling is referred to as Norwegian Quality Cut and is used for measurement in conformity with NS 9402.....Atlantic Salmon - measurement of colour and fat.

The Norwegian Quality Cut consists of a biological cut section delimited by the distinguishing marks of the anatomy of the fish. In practice the biological section is removed from the gutted fish. The cut is to be delimited at the front by the rear edge of the dorsal fin, and at the back by the anal orifice (see illustrations overleaf).

Step-by-Step Procedure

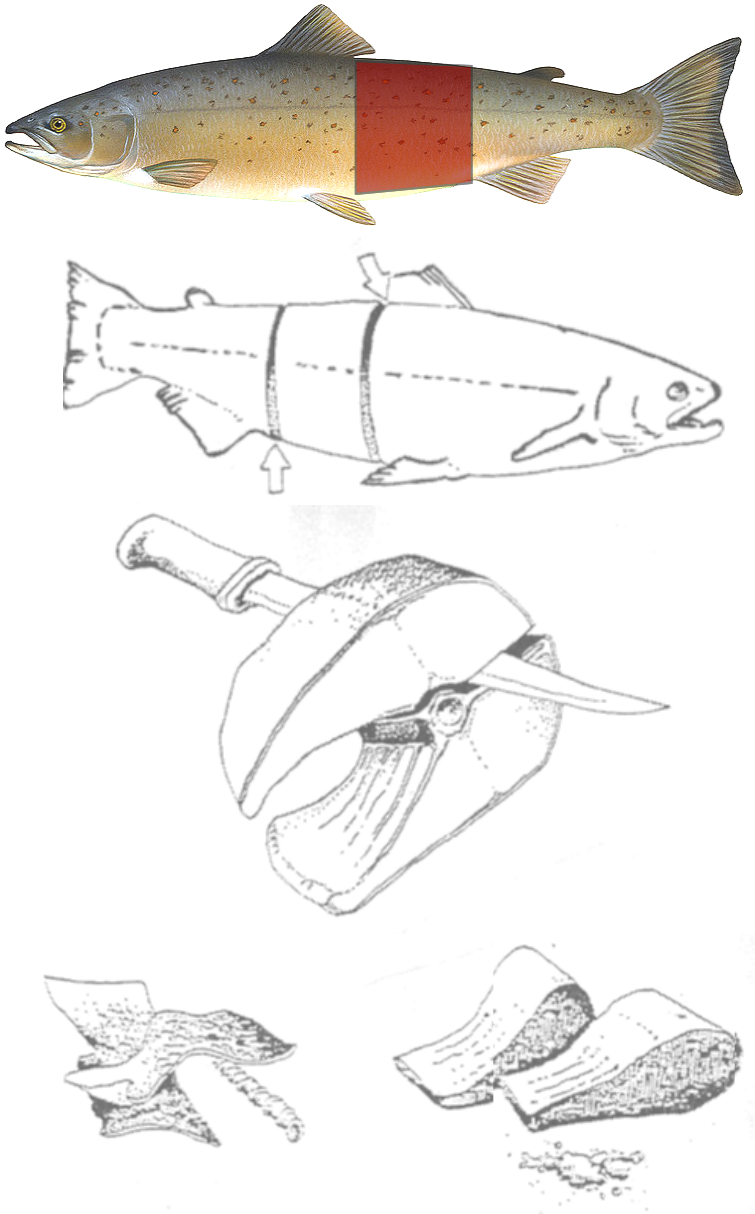
Place the gutted fish on a firm surface, and use a sharp knife so that the cuts are clean and straight.

Front Cut

- place the knife against the base of the rear edge of the dorsal fin,
- place the cutting edge of the knife blade vertically in relation to the line on the side of the fish,
- cut straight downwards.

Rear Cut

- place the knife over the anal orifice,
- place the cutting edge of the knife vertically in relation to the line on the side of the fish,
- cut straight downwards.



Material excluded from Section Sample

Technical Specifications

Sensor

Type:	Microstrip transmission line
Microwave Frequency	2.0 GHz (+/- 20 MHz)
Microwave Power	< 2 milliwatts
Materials	Stainless steel, PTFE

Display

Type	LCD, 2 lines x 12 characters (FFM-692)
	LCD, 2 lines x 16 characters (FFM-992)

Sensor Enclosure

Material	ABS Plastic, waterproofed to IP 65
Size	195mm x 100mm x 40mm
Weight (including batteries)	FFM-992: 375g
	FFM-1092: 600g

Hardware / Software

Capacity	Up to 48 calibrations can be stored in each meter and up to 1000 data samples can be recorded before a download is required.
Software	The Distell Data Management System is supplied with each meter, and is downloadable from our website.
Interface	Distell meters are supplied with a waterproof USB cable that can be used for periodic downloads as well as real time data capture.
Batteries	Powered by internal rechargeable batteries, Nickel Metal Hydride (NiMh)
Charger / Power Supply	Universal charger / power supply, also acts as desktop power supply unit. Fitted with waterproof connector.
	Input voltage 110V – 250V AC, 50 – 60 Hz
	Output voltage 12 V DC, 1.2 A

Declaration of Conformity

The Products covered by this Declaration

The following Electrical / Electronic equipment, manufactured by Distell.com, for measurement, control and laboratory use:

Fish Freshness Meter	- Torrymeter
Fish Fatmeter	- FFM 692, FFM 992
Meat Fatmeter	- MFM 1092, MFM 992
Moisture Meter	- MM 692, MM 992

Directives and Standards to which these Products Conform

Directives

SAFETY	**EEC**	73/23/EEC, 93/68/EEC
EMC	**EEC**	89/336/EEC, 93/68/EEC

CE

Standards

SAFETY	**EEC**	EN 60950: 2000, as amended	
EMC	**EEC**	EN61326-1 : 2006	EN/CISPR 11: 2003 (Class B)
	EEC	EN/IEC61000-3-2: 2006	EN55011: 1998+A1: 1999+A2: 2002 (Class B)
	EEC	EN/IEC61000-3-3: 2002	EN/IEC61000-4-2: 1995 +A1 + A2
	EEC	EN/IEC61000-4-3: 2002 +A1	EN61000-4-4: 2004
	EEC	EN/IEC61000-4-5: 1995 +1	EN/IEC61000-4-6: 1996 +A1
	EEC	EN/IEC61000-4-11: 2004	
	FCC	CFR47: 2005 - Part 15, Sub Part B (Class B) (US Federal code of regulations), Consisting of : Clause 15.107, Clause 15.109	
	VCCI	Agreement of VCCI: 2006.4 (Class B),In conformance with : Table 4.2, Table 4.6	

DATE OF ISSUE: 1st December 2000, updated 1st July, 2008

YEAR CE MARKING FIRST AFFIXED: 2000

David T. Fulton, Proprietor & General Manager

Distell.com, Old Levenseat, Fauldhouse, West Lothian, Scotland – UK.

Application Data Sheets

Application Data Sheet 1

TITLE: Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.

PRODUCT: Atlantic Salmon

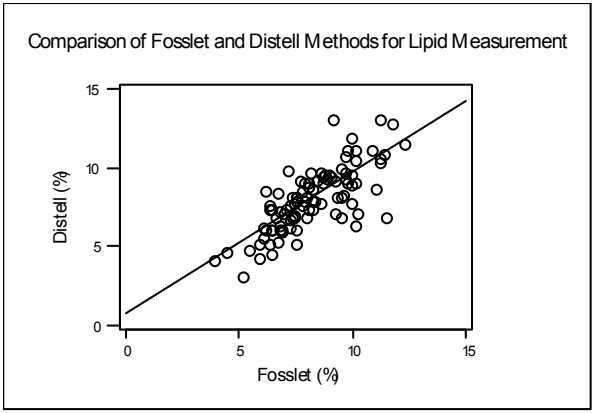
DATA SOURCE: Major UK fish processor.

SAMPLING METHOD: Four measurements made on each side of the fish above the lateral line, using Distell's measurement methodology for SALMON-1.

Please refer to the relevant calibration chart for further details.

Fosslet analysis on the trimmed section taken from below the dorsal fin.

STATISTICS:		
	Number of fish:	97
	Maximum lipid content (Fosslet):	12.2%
	Minimum lipid content (Fosslet):	3.8%
	Regression equation, y = a + bx:	a=0.704; b=0.906
		(y is Fatmeter result, x is Fosslet)
	Correlation coefficient (r):	0.758
	Standard error:	± 1.32



Comments

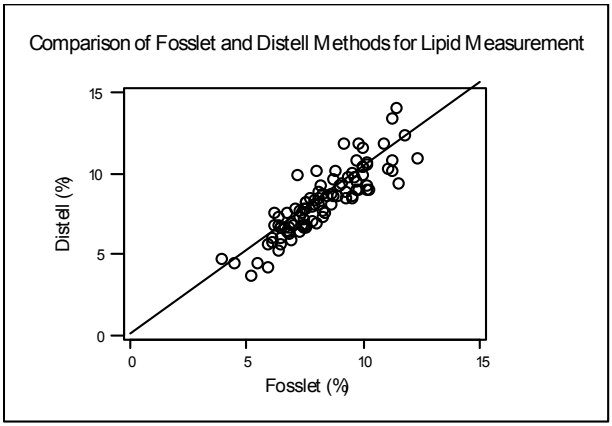
Although the correct measurement method was used for the Fatmeter readings, the Fosslet analysis was carried out on a section taken from below the dorsal fin. Distell's Salmon-1 calibration is representative of the 2x trimmed fillets of the fish, and using only the section under the dorsal results in a poor correlation between the Fatmeter and laboratory analysis.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 2

TITLE:	Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.	
PRODUCT:	Atlantic Salmon.	
DATA SOURCE:	Major UK fish processor.	
SAMPLING METHOD:	Four measurements made on each side of the fish above the lateral line, using Distell's measurement methodology for SALMON-1.	
	Please refer to the relevant calibration chart for further details.	
	Fosslet analysis on the trimmed section taken from below the dorsal fin.	
STATISTICS:	Number of fish:	97
	Maximum lipid content (Fosslet):	12.2%
	Minimum lipid content (Fosslet):	3.8%
	Regression equation, y = a + bx:	a = 0.926; b = 0.835
		(y is Fatmeter result, x is Fosslet)
	Correlation coefficient (r):	0.748
	Standard error:	±1.26



Comments

Although the correct measurement method was used for the Fatmeter readings, the Fosslet analysis was carried out on a section taken from below the dorsal fin. Distell's Salmon–1 calibration is representative of the 2x trimmed fillets of the fish, and using only the section under the dorsal results for the laboratory analysis results in a poor correlation between the Fatmeter and laboratory analysis.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 3

TITLE: Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.

PRODUCT: Atlantic Salmon.

DATA SOURCE: Major UK fish processor.

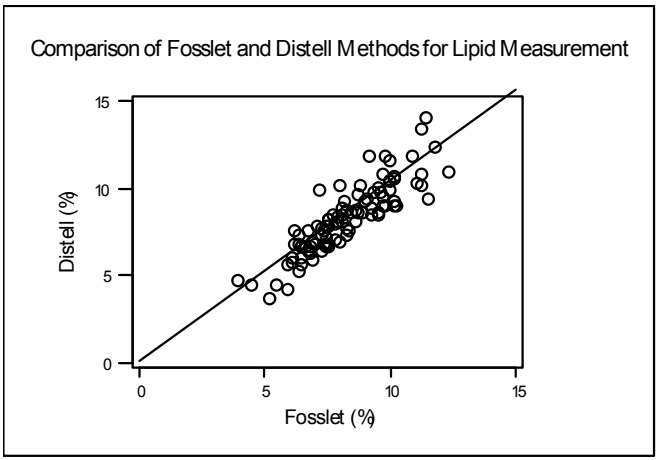
SAMPLING METHOD: Four measurements made on each side of the fish at points directly beneath the dorsal fin (Mowi Section), using Distell's measurement methodology for SALMON-2.

Please refer to the relevant calibration chart for further details.

Fosslet analysis on correctly prepared "Mowi Section".

STATISTICS:

Number of fish:	97
Maximum lipid content (Fosslet):	12.2%
Minimum lipid content (Fosslet):	3.8%
Regression equation, y = a + bx:	a = 0.066; b = 1.038
	(y is Fatmeter result, x is Fosslet)
Correlation coefficient (r):	0.878
Standard error:	±0.964



Comments

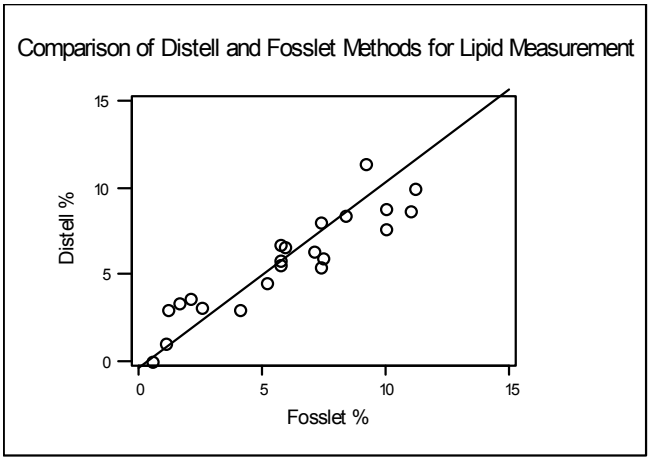
The correct measurement method was used for the Fatmeter readings, and the Fosslet analysis was carried out on the correctly prepared "Mowi Section". Distell's Salmon–2 calibration is representative of the Mowi Section of the fish, and by preparing the proper sample for the laboratory analysis has resulted in a high correlation between the Fatmeter and laboratory analysis.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 4

TITLE:	Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.	
PRODUCT:	Atlantic Salmon.	
DATA SOURCE:	Torry Research Station.	
SAMPLING METHOD:	Four measurements made along the length of the fish, above the lateral line, using Distell's measurement methodology for SALMON-1.	
	Please refer to the relevant calibration chart for further details.	
	Fosslet analysis on correctly prepared 2x Trimmed Fillets.	
STATISTICS:	Number of fish:	22
	Maximum lipid content (Fosslet):	11.4%
	Minimum lipid content (Fosslet):	0.11%
	Regression equation, y = a + bx:	a = 0.297; b = 1.06
		(y is Fatmeter result, x is Fosslet)
	Correlation coefficient (r):	0.915
	Standard error:	1.33



Comments

The correct measurement method was used for the Fatmeter readings, and the Fosslet analysis was carried out on the correctly prepared 2x trimmed fillets. Distell's Salmon–1 calibration is representative of the 2x trimmed fillets of the fish, and by preparing the proper sample for the laboratory analysis has resulted in a high correlation between the Fatmeter and laboratory analysis.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 5

TITLE: Comparison of Distell Fatmeter and Bligh and Dyer methods of lipid analysis.

PRODUCT: Herring.

DATA SOURCE: Technological Laboratory of the Danish Ministry of Fisheries.

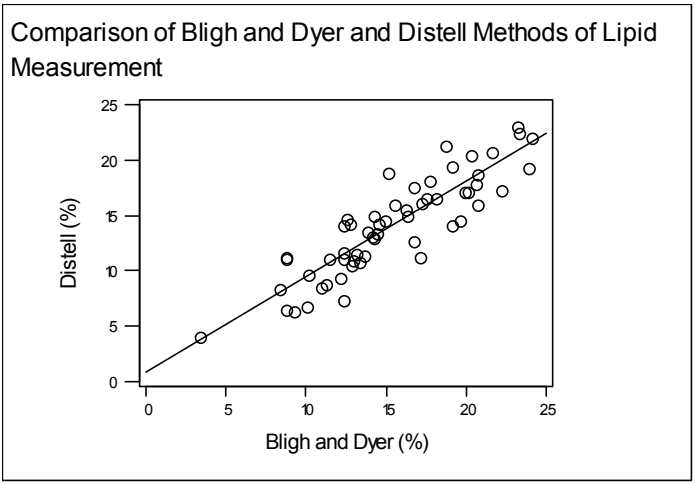
SAMPLING METHOD: Eight measurements made in the centre of each of eight fish, above the lateral line, using Distell's measurement methodology for HERRING-1.

Please refer to the relevant calibration chart for further details.

Bligh and Dyer analysis on correctly prepared 16 x trimmed fillets.

STATISTICS:

Number of fish:	57
Maximum lipid content (B and D):	24.06%
Minimum lipid content (B and D):	3.3.%
Regression equation, y = a + bx:	a = 0.797; b = 0.867
	(y is Fatmeter result, x is B&D)
Correlation coefficient (r):	0.884
Standard error:	± 2.08



Comments

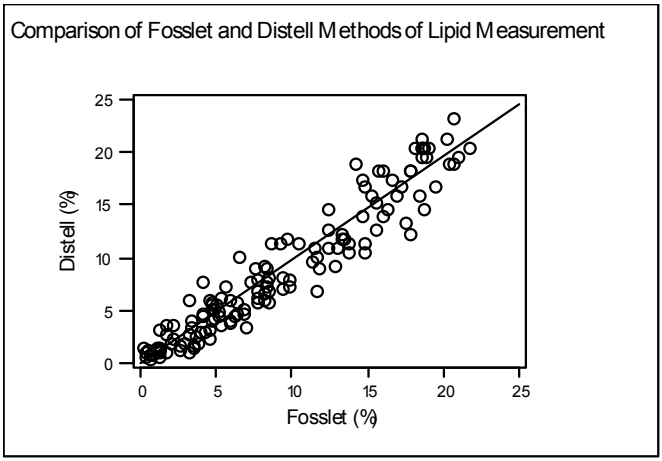
The correlation obtained with this method was good despite the fact that the standard procedure was not followed. Improvements gained by averaging 8 x 8 samples were lost by using the Bligh and Dyer method for fat measurement. This method is known to correlate poorly with Fosslet Chemical Method.

Conclusion

As Distell has correlated their calibrations against Fosslet Method, then best comparison is gained by using Fosslet Method during Laboratory analysis.

Application Data Sheet 6

TITLE:	Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.	
PRODUCT:	Herring	
DATA SOURCE:	Torry Research Station, UK Ministry of Agriculture Fisheries and Food.	
SAMPLING METHOD:	One measurement made just above and parallel to the lateral line on each fish. Distell's measurement methodology for HERRING-1.	
	Please refer to the relevant calibration chart for further details.	
	Fosslet analysis on correctly prepared 2x trimmed fillets.	
STATISTICS:	Number of fish:	137
	Maximum lipid content (Fosslet):	21.5%
	Minimum lipid content (Fosslet):	0.16%
	Regression equation, y = a + bx:	a = 0.069; b = 0.984
	Correlation coefficient (r):	0.955
	Standard error:	±1.87



Comments

The correlation obtained with this method was very high despite the fact that the standard procedure was not followed. Individual fish rather than eight fish were measured. For the average of eight fish the results would be even better.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 7

TITLE: Comparison of Distell Fatmeter and Soxhlet Methods of Lipid Analysis.

PRODUCT: Atlantic Salmon

DATA SOURCE: Major French producer.

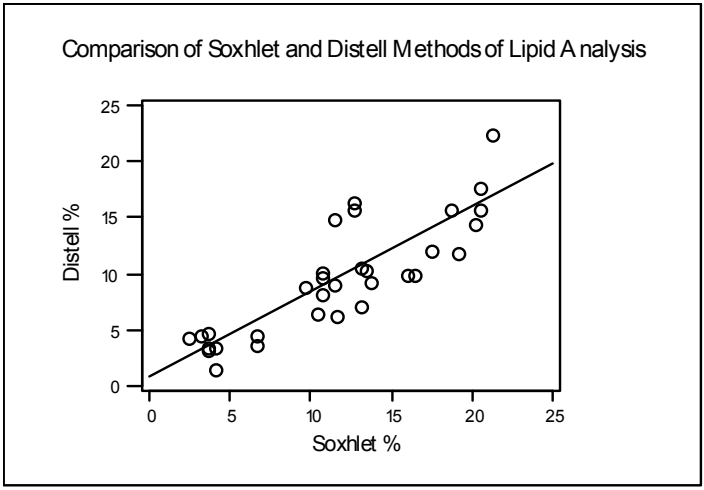
SAMPLING METHOD: Four measurements made along the length of the fish, above the lateral line. Distell's measurement methodology for SALMON-1.

Please refer to the relevant calibration chart for further details.

Soxhlet analysis carried out on the actual parts of the flesh measured by the Fatmeter, pooled for each side of the fish and compared with the average meter reading for those four places.

STATISTICS:

Number of fish:	32
Maximum lipid content (Soxlet):	21.0%
Minimum lipid content (Soxlet):	2.25%
Regression equation, y =a + bx:	a=0.811; b=0.759 (y is Fatmeter result, x is Fosslet)
Correlation coefficient r:	0.85
Standard error:	±2.7



Comments

The correlation obtained with this method was good despite the fact that the standard procedure was not followed. The low b-value probably arises from this difference in method. Although the correlation coefficient is high, the large standard error is a reflection of the presence of several outliers.

Conclusion

Always follow Distell's recommended calibration methodology rigorously if you wish to achieve a high correlation with laboratory analysis.

Application Data Sheet 8

TITLE: Comparison of Distell Fatmeter and Soxhlet methods of lipid analysis.

PRODUCT: Sea Bass, trimmed fillets.

DATA SOURCE: IFREMER, Nantes.

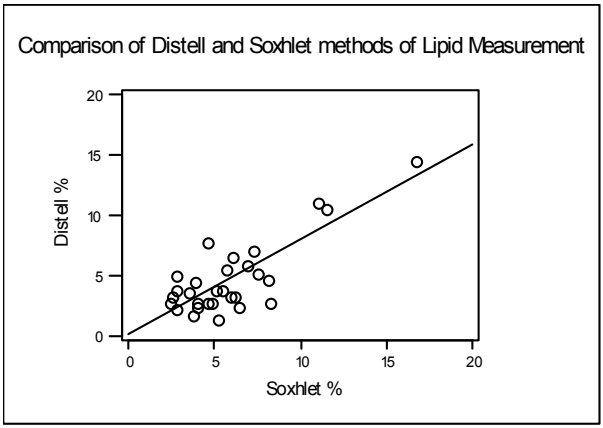
SAMPLING METHOD: Three uncalibrated measurements made along the length of the fish, both sides, above the lateral line, using the SALMON-1 calibration at the following points:

- just behind the gills,
- directly beneath the dorsal fin,
- directly behind the dorsal fin,

Not using Distell methodology. Soxhlet analysis carried out on 2x trimmed fillets.

STATISTICS:

Number of fish:	29
Maximum lipid content (Soxlet):	16.6%
Minimum lipid content (Soxlet):	2.4%
Regression equation, y = a + bx:	a = 0.234; b = 0.783
	(y is Fatmeter result, x is Fosslet)
Correlation coefficient (r):	0.80
Standard error:	±1.86



Comments

The data here was obtained on Sea Bass, for which the meter had not been calibrated. They were also obtained in a manner that was not the recommended procedure for any species. This was because of the fact that this was one of the first studies of this species, and the measurement method was designed to be optimal for the fish shape and size. Both these factors explain the low value of b.

Conclusion

Distell has since developed a calibration for Sea Bass, and the optimum methodology, as described in the User Manual, will allow a high correlation between Fatmeter and laboratory method.

Application Data Sheet 9

TITLE: Comparison of Distell Fatmeter and Soxhlet methods of lipid analysis.

PRODUCT: Sea bass, trimmed fillets.

DATA SOURCE: IFREMER, Nantes.

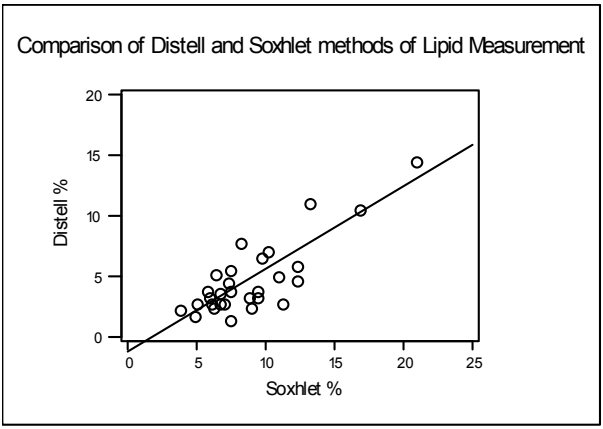
SAMPLING METHOD: Three uncalibrated measurements made along the length of the fish, both sides, above the lateral line, using the SALMON-1 calibration at the following points:

- just behind the gills,
- directly beneath the dorsal fin,
- directly behind the dorsal fin,

Not using Distell methodology. Soxhlet analysis carried out on 2x untrimmed fillets

STATISTICS:

Number of fish:	29
Maximum lipid content (Soxlet):	16.6%
Minimum lipid content (Soxlet):	2.4%
Regression equation, y = a + bx:	a = 1.818; b = 0.675
	(y is Fatmeter result, x is Fosslet)
Correlation coefficient (r):	0.82
Standard error:	±1.72



Comments

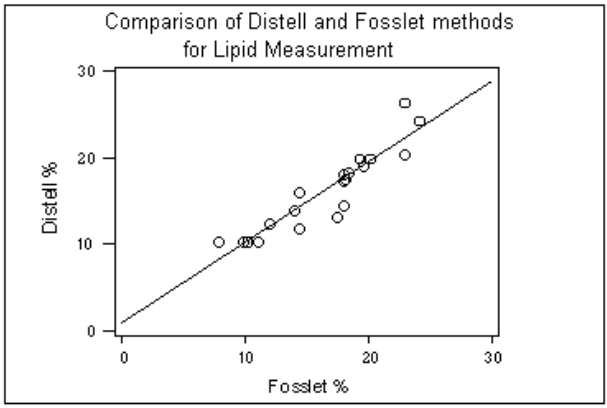
The data here was obtained on Sea Bass, for which the meter had not been calibrated. They were also obtained in a manner that was not the recommended procedure for any species. This was because of the fact that this was one of the first studies of this species, and the measurement method was designed to be optimal for the fish shape and size. Both these factors explain the low value of b.

Conclusion

Distell has since developed a calibration for Sea Bass, and the optimum methodology, as described in the User Manual, will allow a high correlation between Fatmeter and laboratory method.

Application Data Sheet 10

TITLE :	Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.	
PRODUCT:	Smoked Salmon Mince (Atlantic Salmon)	
DATA SOURCE:	Distell.	
SAMPLING METHOD:	Four smoked salmon fillets each cut into 5 pieces and minced.	
	Distell's measurement methodology for SALMON-5.	
	Please refer to the relevant calibration chart for further details.	
	Fosslet analysis carried out on 300g of the blended salmon mince, measured by the Fatmeter.	
STATISTICS:	Number of samples:	20
	Maximum lipid content (Fosslet):	23.95%
	Minimum lipid content (Fosslet):	7.7%
	Regression equation, y = a + bx:	a=-1.164;b=0.924
		(y is Fatmeter result, x is Soxlet)
	Correlation coefficient (r):	0.914
	Standard error:	±1.0



Comments

The data was obtained using FOUR Smoked Salmon Fillets from one Processor.

Conclusion

A new, dedicated calibration had recently been prepared for the above product. Samples supplied by the processor. However, the high correlation achieved is highly dependent upon the smoking and salting regimes of the individual processor. Each processor is likely to have a different smoking and salting technique, which could result in poor correlation between Fatmeter and laboratory results in some cases.

Application Data Sheet 11

TITLE : Comparison of Distell Fatmeter and Fosslet methods of lipid analysis.

PRODUCT : Bluefin Tuna

DATA SOURCE : Distell.

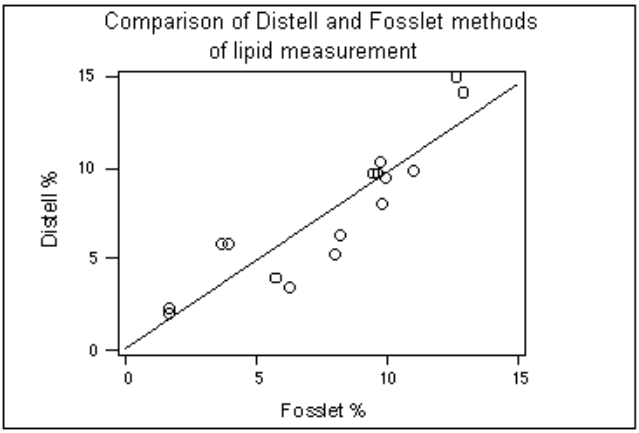
SAMPLING METHOD : Four fillets cut from each of four fish from the central section of the fish and eight readings taken on each section. Distell's measurement methodology for BLUEFIN-1.

Please refer to the relevant calibration chart for further details.

Fosslet analysis carried out using all four fillets.

STATISTICS :

Number of samples:	16
Maximum lipid contents (Fosslet):	12.8%
Minimum lipid content (Fosslet):	1.6%
Regression equation, y = a + bx:	a=0.177;b=0.964
	(y is Fatmeter result, x is Soxlet)
Coefficient correlation (r):	0.892
Standard error:	±1.73



Comments

The samples were collected from fish between 5 - 10 Kg in weight, with the Fatmeter measurements taken through the skin.

Conclusion

Fatmeter Measurements on whole tuna carcass can be affected by the skin thickness, and bone platelets. With the larger tuna fish, great care is necessary, to ensure that meter readings are taken from areas of the fish where skin thickness does not affect the measurements.

Trading Terms and Warranties

In line with most manufacturers, the products that we manufacture and sell are covered by a comprehensive warranty. In order that all customers are fully aware of the terms and conditions of order acceptance, terms of sale and after-sales warranty, we have summarised below our current terms for reference.

Terms and Conditions of Order Acceptance

Orders

An order received by Distell.com (hereinafter referred to as 'The Company') is deemed to be an offer to purchase by the customer, and subject to the conditions herein contained which will be deemed to be accepted by the customer upon delivery of the goods.

Prices

The prices quoted are subject to stock availability and whilst every endeavour will be made to supply at quoted prices, The Company reserve the right to revise prices at any time prior to delivery, upon giving notice to the customer to that effect.

Terms of Payment

Payment for goods is cash with order. Payment for services is due on delivery or completion of services. Any other terms of payment must be confirmed in writing from The Company prior to ordering goods and services. The Company reserves the right to charge interest on overdue accounts at the monthly rate of 5% above base rate.

Terms and Conditions of Sale

Retention of Title

The ownership of any goods supplied by The Company shall remain vested in The Company until full payment has been received. The customer shall be entitled to resell the goods or services only as agents of The Company and shall be bound to account to The Company therefore.

Risk

All risks in relation to the goods will pass to the customer upon delivery to the customer or his agents.

Delivery

Delivery shall be deemed to be effected when the goods have been delivered to the address agreed between the customer and The Company or when collected by or on behalf of the customer.

The Company will endeavour to deliver the goods without delay, but shall not be liable for late delivery howsoever caused, nor shall such failure be deemed to be in breach of any contract.

If for any reason the customer refuses delivery, then without prejudice to any other rights due to The Company, The Company reserves the right to treat the order as cancelled forthwith.

Returns

No returns of goods or services supplied by The Company will be accepted without The Company's prior written consent.

Liability for Loss or Damage

The Company does not accept liability for damage or partial loss of goods or services under the following circumstances:

- where there is a clear signed receipt of delivery to the customer.

- where the customer has signed for receipt of goods marked as unexamined.
- where the customer fails to give notice of any damage or loss within three days of delivery.

Terms and Conditions of After Sales Warranty

Any warranty given is solely confined to the repair / replacement of any product supplied or manufactured by The Company, directly to the customer.

All equipment supplied or manufactured by The Company is covered by a twelve month warranty covering parts and labour. The warranty commences on the date of shipment or, where delivery is by The Company's own staff, from the date of delivery.

The Company warrant that the Equipment shall be free from defects in workmanship and materials. Any equipment that is demonstrably defective on receipt by the customer must be returned within seven working days of receipt of goods to qualify for a free of charge replacement.

Thereafter our sole responsibility shall be to repair or replace the defective product at our discretion, upon receipt at our premises. The faulty equipment must be received properly packaged, protected and insured from Transit Damage.

The Company accepts no responsibility under the warranty for any product that has been opened, tampered with, reprogrammed, altered modified or misused in any way, and in no event shall the company be liable for incidental, consequential, indirect or special damages including, but not limited to damage arising from the loss of use of the product, system or profits, or any claim against the company by any other party.

This warranty is in lieu of all other warranties, whether expressed or implied, including without limitation, implied warranties of merchantability and/or of fitness for a particular purpose.

Following the expiry of the manufacturer's warranty, we strongly advise our customers to avail themselves of our comprehensive service and maintenance contract. This contract covers your equipment and where applicable your installation, for a period of one, two or three years. Note that all labour and parts are covered by this service contract, but shipping, packaging and insurance are payable by the customer. For further details please contact our offices.

In the event of a warranty claim or a service requirement please contact our Returns Department. Details of address and telephone numbers are shown at the rear of this manual.

For a copy of the complete Terms and Conditions, please contact our sales office or distributor.

Contact Details

The

DISTELL FISH FATMETER

is manufactured in the UK by

DISTELL.COM

UNIT 5, OLD LEVENSEAT

FAULDHOUSE

WEST LOTHIAN

EH47 9AD

SCOTLAND

TELEPHONE: +44 (0)1501 770124

FAX: +44 (0)1501 772424

WEBSITE : www.distell.com

EMAIL: info@distell.com